REMARKS

This Amendment/Reply accompanies the Request for Continued Examination (RCE) 37 CFR 1.114 and is in reply to the Final Office Action mailed March 17, 2006. Claims 1-31 were rejected. With this Response, claims 4, 8, 10, 11, 14, 16, 17, 20, 23, 25 and 28-31 have been amended. Claims 1-31 remain pending in the application and are presented for reconsideration and allowance.

Claim Rejections under 35 U.S.C. § 103

Claims 1-31 are rejected under 35 U.S.C. §103(a) as being unpatentable over Collins et al., U.S. Patent Pub. No. 2004/0107909 ("Collins"), and Lee et al., U.S. Patent No. 6,670,224 ("Lee"), in view of Watanabe et al., U.S. Patent Pub. No. 2005/0247985 ("Watanabe"). Applicant submits that Collins, Lee, and Wantanabe, either alone, or in combination, fail to teach or suggest the invention of independent claims 1, 8, 16, and 25.

Independent claim 1 recites a plasma ion implantation system comprising a vacuum chamber; a plasma generator configured to generate ions in the vacuum chamber; a sample holder inside the vacuum chamber; and a voltage source configured to provide a bias voltage between the sample holder in the vacuum chamber to attract ions to implant in a high-k dielectric layer of a sample positioned on the sample holder. The high-k dielectric layer has a k value greater than 9.

Collins discloses a plasma immersion ion implantation process using a plasma source having low disassociation and low minimum plasma voltage. Collins discloses that the torodial plasma immersion ion implantation reactor of Fig. 84 can be operated with a pulsed D.C. bias voltage instead of an RF bias voltage. In this case, the bias power generator 8065 would be a D.C. source rather than an RF source. Thus, in the different operational modes of Figs. 82A through 82H, the pulsed RF bias voltage may be replaced by a pulsed D.C. bias voltage of the same pulse width, with only the source power generator 8055 producing an RF power burst. (Paragraph 0277). Further, Collins discloses that in a plasma containing a fluoride and/or hydride of a dopant gas such as BF_3, there is a distribution of various ion species, such as BF_2+,

BF+, B+, F+, F- and others (such as inert additives). All types of species may be accelerated across the sheath and may implant into the wafer surface. (Paragraph 0249).

Lee discloses a method for manufacturing thin film transistors. A buffer layer 302 and an amorphous thin film are in turn formed on an insulating transparent substrate 300. (Column 3, lines 19-21). The material of buffer layer 302 is silicon oxide, silicon nitride, or a combination thereof. The buffer layer 302 is formed over the insulting transparent substrate by physical vapor deposition (PVD), low pressure chemical vapor deposition (LPCVD), or plasma enhanced chemical vapor deposition (PECVD). (Column 3, lines 29-36).

Wantanabe discloses a semiconductor device having, on a silicon substrate a gate insulating film and a gate electrode in this order; wherein the gate insulating film comprises a nitrogen containing high-dielectric-constant insulating film which has a structure in which nitrogen is introduced into metal oxide or metal silicate; and the nitrogen concentration in the nitrogen containing high-dielectric-constant insulating film has a distribution in the direction of the film thickness; and a position at which the nitrogen concentration in a nitrogen containing high-dielectric-constant insulating film reaches the maximum in the direction of the film thickness is present in a region at a distance from the silicon substrate. A manufacturing method of a semiconductor device comprising the steps of making the introduction of nitrogen by irradiating the high-dielectric-constant insulating film which is made of metal oxide or metal silicate, with a nitrogen containing plasma is also provided. This improves the thermal stability of the high-dielectric-constant insulting film, suppresses the dopant penetration and, in addition, prevents electric characteristics of the interface with the silicon substrate from deteriorating. (Abstract). Wantanabe further discloses that the control on the nitrogen distribution at the gate insulating film may be achieved by nitrating selectively a region other than the vicinity of the silicon substrate through the exposure to a nitrogen containing plasma or the step of forming, on the silicon substrate, a layered structure composed of a metal layer and a nitrogen containing layer, and thereafter applying an oxidation treatment thereto. (Paragraph 0069). The high-dielectric-constant film is selectively nitrided by irradiation with a nitrogen containing plasma, or the nitrogen is introduced and its profile is controlled by the step of oxidizing a layered structure

of a metal layer and a nitrogen containing layer. (Paragraph 0073). In a first method making use of plasma irradiation, a gate insulating film (without nitrogen introduction) comprising a high-dielectric-constant insulating film is formed on a silicon substrate and the irradiation with active nitrogen formed by plasma is applied thereto. (Paragraph 0074). In a second manufacturing method, the nitrogen concentration profile in the film can be controlled by the oxidation treatment of the layered structure shown in the flow diagram of Fig. 2. (Paragraph 0075).

Collins, Lee, and Wantanabe, either alone, or in combination, fail to teach or suggest a **voltage source configured to provide a bias voltage between the sample holder and the vacuum chamber to attract ions to implant in a high-k dielectric layer of a sample positioned on the sample holder, wherein the high-k dielectric layer has a k value greater than 9**. The Examiner admits that both Collins and Lee fail to teach the use of a high-k dielectric layer having a k value greater than 9. (Office Action page 5). The Examiner submits that Wantanabe discloses a high-k material subjected to plasma nitridation. Wantanabe, however, does not include a high-k dielectric layer that is being implanted with ions. Rather, the high-k dielectric layer disclosed in Wantanabe is irradiated with a nitrogen plasma. Irradiation with a nitrogen plasma does not disclose implantation of the high-k material.

In addition, there is no suggestion to combine Collins and Lee with Wantanabe. Wantanabe does not include an implantation process but rather an irradiation process. Accordingly, one skilled in the art would not combine the implantation system of Collins to generate the semiconductor device of Wantanabe since the semiconductor device of Wantanabe does not include an implantation of the high-k dielectric layer.

In view of the above, Applicant respectfully submits that the above rejection of independent claim 1 under 35 U.S.C. §103(a) should be withdrawn. Dependent claims 2-7 further define patentably distinct independent claim 1. Accordingly, Applicant submits that these dependent claims are also allowable over the cited references. Allowance of claims 1-7 is respectfully requested.

Further, Collins, Lee, and Wantanabe either alone, or in combination, fail to teach or suggest **wherein the voltage source comprises a constant DC voltage source** as recited in

amended dependent claim 4. In contrast, Collins discloses a pulsed DC power source 8065. (Paragraph 0277).

Collins, Lee, and Wantanabe, either alone, or in combination, also fail to teach or suggest the invention recited by independent claim 8 including **a constant DC voltage source configured to accelerate positive ions towards a high-k dielectric layer of the sample to implant the positive ions in the high-k dielectric layer and to repel negative ions from the sample**. In contrast, Collins discloses a pulsed DC voltage source in which all ion species are accelerated across the sheath and implanted into the wafer surface. (Paragraph 0249).

In view of the above, Applicant respectfully submits that the above rejection of independent claim 8 under 35 U.S.C. §103(a) should be withdrawn. Dependent claims 9-15 further define patentably distinct independent claim 8. Accordingly, Applicant submits that these dependent claims are also allowable over the cited references. Allowance of claims 8-15 is respectfully requested.

For the same reasons as discussed above with reference to claim 8, Collins, Lee, and Wantanabe either alone, or in combination, fail to tech or suggest the invention recited by amended independent claim 16 including **a voltage source configured to accelerate positive ions towards a first high-k dielectric layer of the sample to implant the positive ions in the first high-k dielectric layer and to repel negative ions from the sample**.

In view of the above, Applicant submits that the above rejection of independent claim 16 under 35 U.S.C. §103(a) should be withdrawn. Dependent claims 17-24 further define patentably distinct independent claim 16. Accordingly, Applicant submits that these dependent claims are also allowable over the cited references. Allowance of claims 16-24 is respectfully requested.

Further, for the same reasons as discussed above with reference to claims 4 and 8, Collins, Lee, and Wantanabe, either alone, or in combination, also fail to teach or suggest **wherein the voltage source is a constant DC voltage source** as recited in amended dependent claim 23.

For the same reasons as discussed above with reference to claim 8, Collins, Lee, and Wantanabe, either alone, or in combination, also fail to teach or suggest the invention recited by amended independent claim 25 including **accelerating positive ions in the plasma toward the sample to implant the positive ions in the high-k dielectric layer while repelling negative ions from the sample.**

In view of the above, Applicant respectfully submits that the above rejection of claim 25 under 35 U.S.C. §103(a) should be withdrawn. Dependent claims 26-31 further define patentably distinct independent claim 25. Accordingly, Applicant submits that these dependent claims are also allowable over the cited references. Allowance of claims 25-31 is respectfully requested.

Further, Collins, Lee, and Wantanabe, either alone, or in combination, fail to teach or suggest **wherein accelerating positive ions in the plasma toward the sample comprises biasing the sample with a constant DC voltage** as recited in amended dependent claim 28, **wherein accelerating positive ions in the plasma toward the sample to implant the positive ions in the sample comprises implanting the positive ions having a dose greater than 1 x 10^{13} ions/cm^2 and less than 1 x 10^{16} ions/cm^2** as recited in amended dependent claim 30, and **wherein accelerating positive ions in the plasma toward the sample to implant the positive ions in the sample comprises accelerating the positive ions to have an implant energy greater than 5 eV and less than 10 keV** as recited in amended dependent claim 31.

CONCLUSION

In view of the above, Applicant respectfully submits that pending claims 1-31 are in form for allowance and are not taught or suggested by the cited references. Therefore, reconsideration and withdrawal of the rejections and allowance of claims 1-31 is respectfully requested.

No fees are required under 37 C.F.R. 1.16(b)(c). However, if such fees are required, the Patent Office is hereby authorized to charge Deposit Account No. 50-0471.

The Examiner is invited to contact the Applicant's representative at the below-listed telephone numbers to facilitate prosecution of this application.

Amendment/Reply
Applicant: Hong-Jyh Li
Serial No.: 10/816,503
Filed: April 1, 2004
Docket No.: 2004P51130US/I331.228.101
Title: PLASMA ION IMPLEMENTATION SYSTEM

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CERTIFICATE UNDER 37 C.F.R. 1.8:

The undersigned hereby certifies that this paper or papers, as described herein, are being transmitted via facsimile to Facsimile No. (571) 273-8300 on this 17 day of May, 2006.

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